VOL. XXXII APRIL 1948 NO. 2

THE JOURNAL OF AGRICULTURE

of the

UNIVERSITY OF PUERTO RICO

THE INSECTS OF PUERTO RICO

By *George N. Wolcott*

COLEOPTERA

PUBLISHED BY
UNIVERSITY OF PUERTO RICO
THE AGRICULTURAL EXPERIMENT STATION
Río Piedras, P. R.

miamii Cartwright, from Mona Island (Ramos 1947–41),
strigicauda Bates, from Puerto Rico and Virgin Islands,
tenebrosus Arrow, from Puerto Rico and Vieques,
versicolor Schmidt, and
vincentiae Arrow.

Psammodius bidens Horn is rare, only one recent collection having been made on the beach at Humacao by Dr. R. E. Blackwelder.

The dull, dirty, yellowish-brown **Trox suberosa** Fabricius is a scant half inch long, a tropicosmopolitan species, noted by Drs. Stahl and Gundlach under the name of *Trox crenatus* Olivier. Mr. C. T. Murphy, of Guánica Centrale, was presumably in error in thinking that it was responsible for damage to sugar-cane that he noted, as it is normally a scavenger, and has been found at Río Piedras under a dead rat. Despite its filthy habits, it is eaten by the none too particular *Bufo marinus*, which it almost exactly matches in color and texture of integument. Possibly most of the beetles collected have been picked up under light. Prof. J. A. Ramos found one on Mona Island, at light.

The introduction of the giant Surinam toad. *Bufo marinus* (L.), has made a greater change in the bulk and composition by bulk of the insect population of Puerto Rico than any other single factor since the clearing of the native forest from the more level portions of the Island in the immediately post-Colombian period. In the cane fields which ever increasingly came to occupy the greater part of the more fertile vegas of Puerto Rico, especially and with increasing rapidity after the occupation by troops of the U. S. Army in the Spanish-American war, a population of native species of white grubs feeding on the roots of sugar-cane and other crops was gradually built up, and finally reached such a peak of abundance as to become the decisive factor in determining whether the growth of sugar-cane or any other crop was possible. In the irrigated land of the south coast which the development of reservoirs in the mountains and the sinking of wells made otherwise suitable for cane growing, white grubs became most abundant, but they were present in destructive abundance everywhere on the Island that agriculture was practised. *White grubs were the major insect pest of every crop grown.* It was to discover some means for the control of white grubs that the Sugar Producers' Association started the Experiment Station at Río Piedras. Numerous other small insects, such as common springtails, aphids or ants might possibly have been numerically more abundant, but certainly in bulk, the white grubs of Puerto Rico greatly overbalanced all the other insects of the Island, not only individually, but all other insects combined. Nowhere else in the world did such an ideal environment await the introduction of *Bufo*, which in its native Guiana must be content to feed on ants and miscellaneous insects.

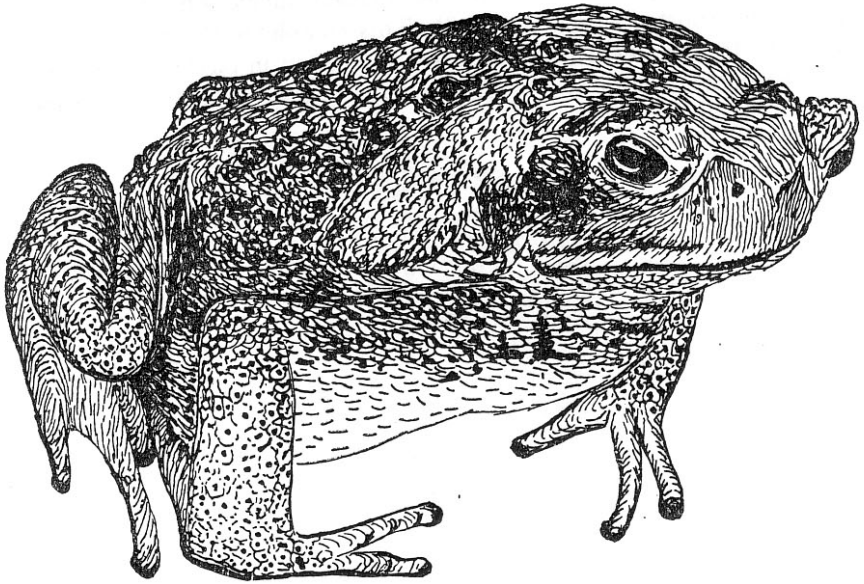
The only parallel is the enormous abundance, reported by R. S. Tohler and A. G. Cooling of individuals of the same "Toads in the Marianas" (Science, **101** (2635): 678. Lancaster, June 29, 1945) following introduction from Hawaii, via Guam, undoubtedly due to a comparable temporarily enormous food supply.

The habits of the May beetles, which are the adults of white grubs, dovetail perfectly with the food requirements of *Bufo*, for they are comparatively slow-moving, terrestrial for two periods each night: when they emerge from the ground to fly to the branches of trees for feeding, and again when they return to burrow in the ground at the base of trees, besides being both large and abundant.

Possibly the greatest damage to sugar-cane caused by white grubs was in the years just before World War I, at Guánica Centrale and its colonos, where Otaheite or White Transparent (Caña Blanca) cane was still being grown. This old variety does wonderfully well in new land, but it does not have a strong root system, and when white grubs completely destroy both rootlets and root-stock, it rots quickly, even before it can be harvested. It was customary for the mill to begin grinding by the middle of December, in an attempt to rescue something from the fields most heavily infested, but this was no solution of the problem. In an attempt to use varieties with more vigorous root systems, those recently developed in Barbados were tested, and Mr. H. Bourne, who had helped the Hon. John R. Bovell in rearing them, was brought to Guánica (Hda. Santa Rita) to breed new varieties on the spot. All Bourne's work went for naught, however, when mosaic disease infected every stool of every one of these promising new seedlings. To escape mosaic disease, the spindly Uba cane was planted, its only recommendation being that it was immune to mosaic and it could grow on unirrigated land. Uba was only a stop-gap, however, until a really superior cane could be found, but the introduction and spread of BH(10)12 a few years later was possible only because the white grub problem was solved (unfortunately, only temporarily, as we now know) by that time.

Mr. D. W. May, Director of the Agricultural Experiment Station at Mayagüez, obtained a few toads from Barbados in 1920, and Mr. R. Menéndez Ramos, Director of the Insular Experiment Station at Río Piedras, brought some in person from Jamaica in the winter of 1923–24. From these two introductions have descended all the toads that had eliminated white grubs from cane fields by a few years later. The shallow lagoons near Guánica, and the smaller irrigation reservoirs and ditches along the remainder of the south coast provided a suitable environment for the development of the immature stages of *Bufo marinus*, and the enormous number of May beetles for months each spring and fall was an apparently

inexhaustible supply of suitable food for the adults, until it was gone. Some of the men at Aguirre claimed that the use of subsoiling Fowler gyro-tiller killed the grubs in the soil that it plowed up, but its extensive use merely happened to coincide with the enormous increase in toad population which was the real cause of the disappearance of the white grubs. By 1932, when the Fourth Congress of the International Society of Sugar-Cane Technologists was held in Puerto Rico, the results of the presence of the toad were too obvious to be ignored. "The Food Habits of the Introduced Toad, *Bufo marinus*, in the Sugar-Cane Sections of Porto



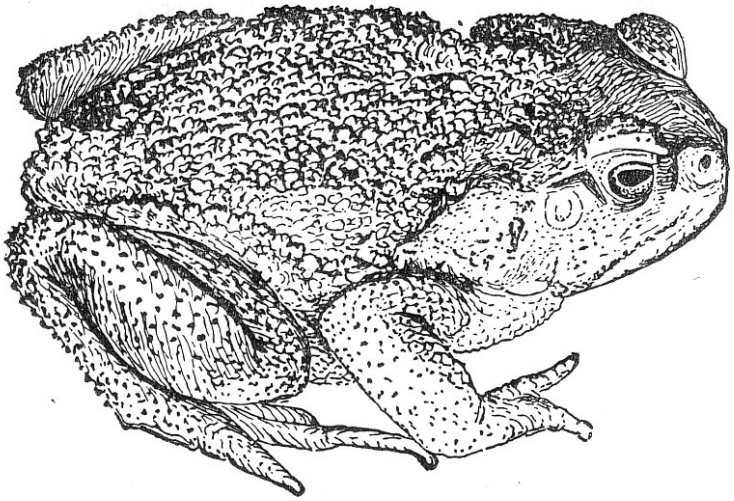
Female of the introduced Giant Surinam Toad, *Bufo marinus* (L.), less than natural size. (Drawn by G. N. Wolcott.)

Rico" (Bulletin No. 74, San Juan, March 1932) which had been investigated by Mrs. Raquel Dexter, detailed both the beneficial and the injurious aspects, the former so greatly preponderating that the entomological delegate from Hawaii, Mr. C. E. Pemberton, promptly made a shipment of them to Hawaii, and took more with him in person.

No such apparently inexhaustible food supply awaited *Bufo* in Hawaii as it had found in Puerto Rico, but otherwise the environment was suitable, and the benefits of its introduction in practically eliminating many kinds of insect pests were so apparent that introductions were made from there to Queensland, Australia, and to many of the smaller islands of the Pacific.

The story of the giant Surinam toad is incomplete without mention of the

experiences of Mr. Walter F. Jepson, whose "Report on the Search for Parasites of *Phytalus smithi* Arr., Field Investigations on Parasites of White Grubs in the United States and Puerto Rico, and their Shipment to Mauritius" (pp. 66, Port-Louis, Mauritius, 1936) gives an exceptionally good picture of the white grub situation in Puerto Rico at the time he was here. He struggled manfully to carry out his instructions to ship insect parasites of white grubs to Mauritius, but it was so obvious that effective control was primarily due to the toads, and not to insects, that in addition he took with him sixty live toads. The authorities in Mauritius, totally



Male of the introduced Giant Surinam Toad, *Bufo marinus* (L.), less than natural size. (Drawn by G. N. Wolcott.)

unprepared for such an importation, ordered the toads destroyed and years later, when finally convinced, had fresh shipments made from Puerto Rico.

Following the peak of abundance of *Bufo marinus* in Puerto Rico, when every possible source of food was devoured, and the toads spread into the less suitable environments of all but the highest mountains, the result was to reduce the common white grub population to a minimum, and apparently to exterminate at least one of the less common species. The investigations of Mr. E. Greywood Smyth on "The White-Grubs Injuring Sugar Cane in Porto Rico" (Jour. Dept. Agr. P. R. 1 (2 & 3): 47–92 & 141–169, illus. San Juan, 1917), confined to the coastal regions, indicated only four endemic species in Puerto Rico, of which the medium-sized one which he named and described as **Phyllophaga guanicana** occurred only in the Guánica region. His type material proves the former existence of this insect, but not a single individual has been collected since, altho Dr. Stuart T. Dan-

forth, the College of Agriculture at Mayagüez, always urged his students from the Yauco and Guánica regions to look for it, when they entered his classes in entomology.

Nor is this the **Lachnosterna monana** of Herr J. Moser (Stettiner Ent. Zeitung, **82:** 181. Stettin, 1921), a similar medium-sized species from the similar xerophytic environment of Mona Island, where toads do not occur, and these May beetles are correspondingly numerous even to the present time.

Somewhat larger than Smyth's *guanicana* is his **Phyllophaga citri,** abundant in all the humid coastal regions of the Island, the adults often collected feeding on the leaves of citrus trees, and, to that extent, economic pests. Judging by size alone, this may be presumed to be Moser's *Lachnosterna insulicola* ("Neue Arten der Gattunger *Lachnosterna* Hope und *Phytalus* Er. (Col.)," Stettiner Ent. Zeitung, **79:** 19–76. Stettin, 1918), but the letter and package containing all the common Puerto Rican May beetles sent to him some years ago for comparison with his types, were returned by the German post-office marked "Gestorben," and it is doubtful if even his types are in existence today.

The only other of the less common coastal species is the large and extremely hairy **crinitissima,** which Mr. J. D. More described in "Insectae Portoricensis" (1924–105) from a holotype male collected at light at Pt. Cangrejos, of which many adults were later collected by Dr. W. A. Hoffman in Muñoz Rivera Park, Puerta de Tierra. Johnny More noted as one of its characteristics "tooth of tarsal claw wanting," which Mr. Lawrence W. Saylor in his "Notes on Beetles related to *Phyllophaga* Harris, with the Descriptions of New Genera and Subgenera" (Proc. U. S. National Museum, **92** (3145): 157–161, pl. 1. Washington, D. C., 1942) used as the basis for making the new monobasic subgenus: **Abcrana.**

Intensive collecting in the higher mountains of Puerto Rico has indicated, to date, the presence at these altitudes of at least four additional species of May beetles. Presumably these mountainous species are as abundant now as when Smyth made his intensive studies of the coastal species, for the introduced toad finds these elevations too cold for its comfort, but the beetles are definitely not common. Dr. E. A. Chapin (1935–70) described **Phyllophaga yunqueana** from a holotype male collected by Dr. Leonard Stejneger in 1900, and **Phyllophaga discalis** from a holotype male intercepted by Mr. R. G. Oakley at Indiera, in the mountains above Yauco, and others in the mountains between Mayagüez and Añasco, collected by J. A. Zalduondo when he was in college.

Mr. Lawrence W. Saylor, describing "Ten New West Indian Scarab Beetles of the Genus *Phyllophaga*, with two new Names" (Washington Academy of Sciences, **30** (7): 305–314. Washington, D. C., July 15, 1940),

includes two from Puerto Rico: **Phyllophaga (Phyllophaga) adjuntas,** which "externally resembles *P. citri* Smyth, but differs from that species in the nonpruinose dorsal surface, the much longer male antennal club, and the quite different male sixth abdominal segment," and **Phyllophaga (Phyllophaga) wolcotti** from El Yunque, and others from Indiera in the mountains north of Yauco intercepted by Mr. R. G. Oakley, "most closely related to *P. yunqueana* Chapin, but besides the quite different male genitalia, it may be separated by the darker color; less densely punctate head, nontumid clypeus, and shorter antennal club." This completes the non-economic species of May beetles, all of which are now listed in Saylor's new genus of **Cnemarachis** (1942–159) which "includes nearly all of the described

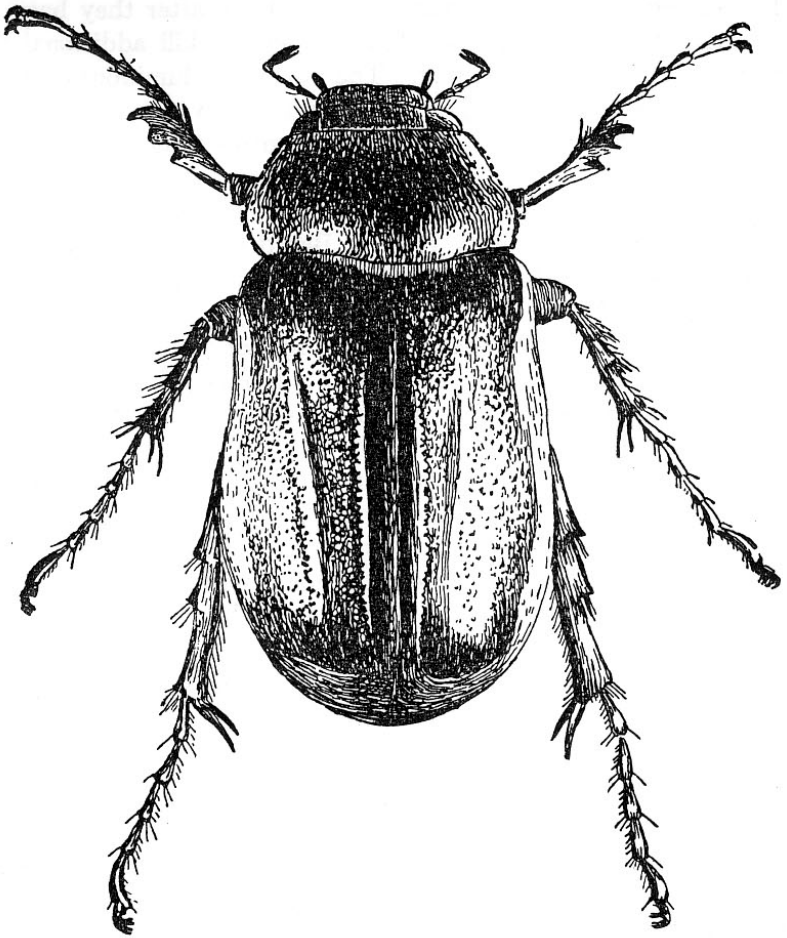
Puerto Rican White Grub, *Phyllophaga* (or *Cnemarachis*) *portoricensis* Smyth, ess than twice natural size. (Drawn by G. N. Wolcott.)

l

West Indian species formerly placed in *Phyllophaga,*" and is characterized by "either middle or hind tibiae or usually both, of both sexes, with an incomplete carina; lateral margins of the middle and hind tibiae usually with obviously serrate edges or with one to several moderately large spines; only rarely do the tibiae lack such carinae or spines or teeth."

The most serious insect pest in Puerto Rico, an endemic May beetle which Mr. E. G. Smyth eventually named **Phyllophaga vandinei** (after Mr. D. L. Van Dine, Entomologist of the Sugar Producers' Station), the type specimens being from Hda. Santa Rita, Guánica, has its distribution limited to the western end of the Island, "its farthest east recorded occurrence being at Manatí on the north coast and Peñuelas on the south." Its eastern analogue, the almost indistinguishable **Phyllophaga portoricensis,** occurs in the remainder of coastal Puerto Rico, and in Vieques. These are big beetles, **Cnemarachis vandinei** adults being 17.0 to 22.0 mm. long, and **Cnemarachis portoricensis** averaging 1.0 to 2.0 mm. larger.

(Judging by the size given by Herr Moser, his *Lachnosterna portoricensis* (1918–62) (= *Phyllophaga borinquensis* Blackwelder), length 21.0 mm., may be either one, as the type locality is merely "Portorico"). The morphological differences noted by Smyth are that in the male genitalia of



The Puerto Rican May Beetle or "Caculo," *Phyllophaga* (or *Cnemarachis*) *portoricensis* Smyth, about three times natural size. (Drawn by G. N. Wolcott.)

vandinei "armatures of theca (are) bicuspidate; spicula sharply deflexed," while in his *portoricensis* the "armatures (are) spatulate at tip; spicula roundly deflexed," but for practical purposes, one identifies them by their geographic distribution. Since this cuts squarely across any natural division of the Island by rainfall or soils, it appears essentially irrational. Economically they are a single species. The adults of both feed indiscriminately on the leaves of sugar-cane, and of many trees. After the first

instar, the grubs eat only live roots of plants. Destruction of the weeds in a field by cultivation forced them to feed on the roots of sugar-cane or of some other crop, and often they were so abundant as to kill the plants the roots of which they attack. Growth of the grubs is rapid, and they may attain full size inside of five months. The entire life-cycle requires but one year, as compared with two years for May beetles of southern United States, three years for many of those of the northern United States, and four years for most of those of Canada. Adults appear in greatest numbers at the time of, or before the spring rains of April, and in somewhat lesser numbers again in late August, with now and then one coming to light at any time from September to March.

Certain especially favored banana plants may be entirely stripped of their leaves by the feeding of one or the other of these species of May beetles, when they are most numerous, but on other trees, the effects of their feeding are not so noticeable. The leaves of introduced trees, like the Australian beefwood (*Casuarina equisetifolia*) and the silver oak (*Grevillea robusta*), often appear to be preferred to what, thru long establishment here, are considered native trees, or those which are really endemic. One may wonder whether the introduction of these foreign trees, plus the extensive growing of sugar-cane, which furnishes preferred food for both adults and grubs, was the lever or factor which so greatly favored these endemic beetles that they could become so abundant, before *Bufo marinus* was introduced, to readjust the balance.

By comparison with what one finds in grub-infested fields in the United States being plowed, those of Puerto Rico would appear to have none of the Scoliid cocoons of the numerous species of *Tiphia* and *Elis* or *Campsomeris*, representing possibly the major factor in the natural control of white grubs in the States. To be sure, representative species of all these Scoliids do occur in Puerto Rico, and a few, attacking other than the economic species of white grubs, are quite abundant, but they are heavily parasitized by numerous Bombyliid flies, thus the influence of the Scoliids attacking the economic species of May beetles is negligible. In all the millions of hand-picked grubs collected at Guánica while Smyth was working on the white grub problem there, not one was noted that was parasitized, nor was a cocoon ever found in the fields being plowed, even when special search was made for them after the releases of Illinois species of *Tiphia* and *Campsomeris*. Very definitely, something must have happened, of which we have no knowledge, since Dr. Gundlach reported *Tiphia argentipes* Cresson as abundant, for no entomologist has ever found it abundant since.

In studying "Porto Rican Cane-Grubs and their Natural Enemies" (Jour. Dept. Agr. P. R., **9** (4): 291–356, fig. 21, ref. 15. San Juan, October 1925), Mr. Harold E. Box was "able to demonstrate that the third instar

grubs are host of the Scoliid wasp, *Dielis (Campsomeris) trifasciata* F., and are also liable to attack by *D. dorsata* F. and *D. pyrura* Roh. The second instar grubs have been found to serve as host for another Scoliid, *Elis xanthonotus* Roh., and it is not improbable that *Lachnosterna portoricensis* is the host of *Elis ephippum* F." These last two are now considered synonymous, but Mr. Walter F. Jepson, rearing them at Cidra, found that the females also attack third instar grubs. He was able to confirm most of Mr. Box' records, and also noted that second instar grubs, in his mountain laboratory, were attacked by *Elis haemorrhoidalis* F. His rearings were made in the mountains, at Cidra, while those of Box were made at Aguirre on the south coast, two entirely different environments, altho only a few miles apart on the map. It is doubtful, however, if the attack of the very common *Campsomeris dorsata* F. and *Elis haemorrhoidalis* F. on the economic species of *Lachnosterna* is normal in the field, which leaves the much less abundant *Elis ephippum* F. (= *Elis xanthonotus* Rohwer), *Campsomeris trifasciata* F. and the rare *Campsomeris tricincta* F. (= *Dielis pyrura* Rohwer) as their only specific parasites. An abundance of hosts normally implies an abundance of parasites, but despite an enormous abundance of hosts, these Scoliid parasites have always been comparatively rare.

That white grubs never generally became as serious a pest in the more humid parts of the Island as they were on the xerophytic south coast is presumably due, in part at least, to specific parasites which were confined to the humid regions. One of these is an endemic Tachinid fly, *Cryptomeigenia aurifacies* described by Mr. W. R. Walton (Proc. Ent. Soc. Washington, **14** (4): 198–200, illus. Washington, D. C., January 10, 1912) from Añasco, and generally present in the more humid areas in Puerto Rico. The adults attack May beetles when they raise their wings in flight, and oviposit in the soft upper side of the abdomen thus exposed. The grubs develop rapidly within the body of the beetle, and, to quote Smyth, "the number of pupae found within one dead adult host varies from two to nine, usually four to six. Infested beetles that have died are always found in their burrows in the ground."

A much less common species, with similar habits, is *Eutrixoides jonesii* Walton. Repeated attempts were made to bring puparia of these flies from Guánica's old Central Pagán property at Añasco to their Hda. Santa Rita, but the flies could not survive such an abrupt change in environment.

Of possibly even greater importance in the natural control of white grubs in the more humid and elevated parts of Puerto Rico is the endemic "cucubano," an eyed Elaterid beetle, *Pyrophorus luminosus* Illiger, the luminous subterranean larvae of which feed on white grubs. A single

larva, reared in the laboratory from egg to pupa, ate 68 white grubs, and would have killed more had they been available. The habits of the charming and innocent fruit-eating adults are in most striking contrast to the unbridled ferocity of their voracious larvae, which, after they have temporarily satisfied their appetite for food, appear to kill additional white grubs merely for the sport of killing. The number of luminous cucubanos which one might see after twilight in a dewy meadow was a very obvious visual demonstration of the number of white grubs that they must have destroyed.

Altho one would never guess from the title of Dr. Alexander Wetmore's "Birds of Porto Rico" (Bulletin No. 15, Board Comm. Agr. P. R., *and* Professional Paper, Bulletin No. 326, U. S. Dept. Agr., pp. 140, pl. 10. Washington, D. C., March 24, 1916) that it was primarily a study of the economic food habits of the native and migratory birds, with especial emphasis on white grubs or May beetles, it is in fact just one facet of the attempt to control these pests by natural means. From the standpoint of the cane growers, its conclusions were rather disappointing, for they already knew from personal observation that the boat-tailed grackle or "mozambique" (*Holoquiscalus niger brachypterus*) fed on white grubs, fearlessly following the bull-teams plowing, and picking up the grubs in the furrows just as soon as they were uncovered by the plow. Even today they follow the snorting tractors, the gyrotillers and the Fowler drag-plows, but until recently found little to reward their courage. That the bare-legged owl feeds upon May beetles or "caculos" means little to cane fields in the vegas, for the owls live mostly in the forested mountains, and possibly if someone had examined their stomach contents obtained by Dr. Wetmore and extracted the male beetle genitalia, these rarer mountainous species of *Lachnosterna* could have been described first. The little blue heron also feeds on caculos, and possibly in the more retired fields of "poyal" lands might be a minor factor in control. This completes the list of local birds having any appreciable effect on the May beetles of Puerto Rico, and Dr. Wetmore hesitated to recommend the introduction of any bird from abroad that might feed on them if it became established here.

The later study by Dr. Stuart T. Danforth of the "Birds of Cartagena Lagoon" (Jour. Dept. Agr. P. R., **10** (1): 1–136, fig. 45, ref. 41. San Juan, January 1926) showed that the least grebe and the killdeer ate beetles, and that grubs were eaten by the local thrush. Dr. Wetmore had emphasized that the cane field environment is most unfavorable for bird life, and the observations of Dr. Danforth offered little additional encouragement, even if they did enlarge the list of birds which, in their own favored environment, might slightly affect the white grub problem.

The investigation by the writer on "The Food of Porto Rican Lizards"

(Jour. Dept. Agr. P. R., **7** (4): 5–37, ref. 8. San Juan, August 1924) indicated that "the common large brown or black tree lizard, *Anolis cristatellus*, is large enough to eat such large, apparently unpalatable and hard to digest beetles as even the May beetles or "caculos." The iguana, *Ameiva exsul*, is amply large enough to eat such beetles, and does in fact eat the white grubs. The iguana is, (however,) exclusively diurnal and the large tree lizard is so largely so that neither of them has any real opportunity to catch May beetles, which are just as exclusively nocturnal."

The iguana is subterranean during most of its existence, usually appearing above ground for only a few hours in the hottest part of the day. It burrows rapidly and easily thru the ground, and eats not only the larval stages but also the eggs of May beetles. Its most serious enemy appears to be the mongoose, *Herpestes birmanicus*, introduced into Puerto Rico first in 1877 and repeatedly in later years. Dr. J. G. Myers in "A Preliminary Report on an Investigation into the Biological Control of West Indian Insect Pests" (Empire Marketing Board **42**, pp. 172. London, July 1931) notes that "wherever the mongoose has become established, it tends to extirpate these lizards everywhere, save in the immediate vicinity of towns. This both Dr. Thomas Barbour, recording "Some Faunistic Changes in the Lesser Antilles" (Proc. New England Zoological Club, **11**: 73–85. Cambridge, January 10, 1930), and myself have observed in a number of the islands." No other explanation of the enormous increase in the number of May beetles in Puerto Rico by the beginning of the twentieth century seems more logical than that it resulted from the wide-spread destruction by the mongoose of what formerly had been its most important natural enemy, the ground-lizard or "iguana," *Ameiva exsul* (Cope).

The prospect for control by native wild vertebrates being so discouraging, the possibility of using hogs for eating white grubs was explored. For years, Guánica Centrale had herds of hogs to compete with the grackles in picking up grubs after the plows, but when no plowing was being done, the pigs had to be fed purchased corn, which was an annoyance to cane growers, and decidedly uneconomical. Women and boys could be hired more cheaply, and millions of grubs and beetles were collected by hand each year for many years, concerning which one may consult the account by Mr. E. H. Barrow giving definite figures (Jour. Dept. Agr. P. R., **8** (2): 22–26. San Juan, April 1924), in every Hacienda on the south coast. Dynamite exploded in a grub-infested field from which the cane has just been cut makes an impressive crater, and sends earth and grubs high in the air, but when they come back to earth, the grubs seem uninjured, and unless promptly captured, soon burrow in among the clods and disappear from sight. This is only the most spectacular of the valueless attempted methods of artificial control, as recounted by Dr. Richard T. Cotton on

"Experimental Work on the Control of White Grubs in Puerto Rico" (Jour. Dept. Agr. P. R., **2** (1): 1–18. San Juan, January 1918). In later years, the use of carbon bisulfide emulsion and of ortho- and paradichlorobenzene was found successful in killing grubs, without injury to the cane plants, but the expense of the chemicals plus that of application made the cost prohibitive, and none of these methods of chemical control has ever been used on a field scale.

Within a few years after *Bufo marinus* became at all abundant, all means of chemical control became obsolete, and practical growers filled gunny sacks full of toads from localities such as lagoons, reservoirs and pools where they could be easily collected in large numbers, and released them in grub-infested cane fields, where they would be of most immediate practical benefit. A few years later, distribution of *Bufo marinus* thru its own efforts had become so uniform and universal that cane growers calmly accepted its beneficial presence as part of the normal processes of nature, tending to forget, after the disappearance of the white grub menace, how serious a threat it had once been to the agriculture of the Island.

The solution of the white grub problem by the introduction of the toad was indeed a major triumph for biological control, at least during the years when it was most effective. Its fundamental weakness was in its very effectiveness however, for despite the supposed omnivorous food habits of the toad, the major elements in Puerto Rico are May beetles and other Scarabaeids, "vaquita" leaf beetles and millipedes. When these are gone, and we have close to total control of white grubs in cane fields, there is little else for the toads to eat. Vast numbers of them must have perished of starvation. As was explained in detail in "What has happened to the giant Surinam Toad, *Bufo marinus* L., in Puerto Rico" (Revista de Agricultura y Comercio de P. R., **38** (1): 25–29, fig. 7. San Juan, January–April 1947), "scarcity of food is only one factor which increasingly tends to limit the abundance of the Surinam toad. In the West Indies at least, the weakest point in its life-history is the tadpole or pollywog stage, which must be passed in fresh water. In addition to all the large and fierce dragon fly nymphs which attack the helpless tadpoles, the even larger and more voracious larvae of the endemic Dytiscid beetle, *Megadytes gigantea* Castelnau, appear to be the deciding factor in whether any tadpoles will survive to become adults. A single one of these large beetles may lay dozens of eggs in a pool, from which emerge small worm-like larvae with enormous jaws. At first they feed on insects and very small animals, but before they are more than half-grown, they attack tadpoles almost ready to leave the water, and often are forced to complete their growth by cannibalistically feeding on each other when every tadpole in the pool has been destroyed."

Reproduction also became more difficult because after three exceptionally

dry years, Cartagena and Guánica Lagoons completely dried up, and thus disappeared the most favorable environments for the development of the tadpoles on the south coast. Rapidly the balance for the toad began to swing in the opposite direction. Cane growers of a new generation, inexperienced in the plagues of white grubs that had infested the fields of their fathers, again began to complain about the abundance of white grubs. When advised to bring toads to infested fields, the problem was where to find the toads.

The rapid increase in abundance in recent years of the common bullfrog of the southeastern United States, *Rana catesbeiana* Shaw, introduced in 1935 into Puerto Rico, at the same time that the toad was becoming so scarce, was thought to indicate a possible incompatibility between the two introduced amphibians. Their pollywogs inhabit the same pools, altho the adults occupy entirely different ecological niches. In a study of the food habits of the frog, Mr. Mario Pérez found that altho the frog may be cannibalistic in devouring its own smaller adults and larvae, it did not eat either the pollywogs or the small adults of *Bufo marinus*. The tadpoles of both feed primarily on aquatic algae, of which an amount ample to feed them rapidly grows on the stones and vegetation of every pool. There is thus no serious competition between frog and toad, either as larva or adult, for the frog adult feeds extensively on aquatic insects and other items, and but rarely on the Maybeetles that are the mainstay of the toad.

"The Rise and Fall of the White Grub in Puerto Rico" (American Naturalist, **84** (816): 181–191, ref. 19. Lancaster, Penn., May–June 1950) shows how essentially temporary was this all too effective control by a single natural factor, and re-emphasized the importance of finding a chemical means of attaining the same end which would be entirely under the control of the grower. It has been found that both aldrin (Hyman 118) and the gamma isomer of benzene hexachloride (BHC) are very toxic to even the largest grubs, as little as 2 pounds per acre of either chemical giving commercial control. In the year and a half that these chemicals have been tested, no appreciable diminution in effectiveness is noticeable, and it is possible that they will render soils to which they have been applied permanently sterile to white grubs.

Much smaller than any of the May beetles just noted, only 8.0 or 9.0 mm. long, is what Smyth described as *Phytalus insularis*, but was later identified as **Phytalus** *apicalis* Blanchard, and is now listed under Saylor's new generic name of **Clemora.** This little beetle occurs not only everywhere in coastal Puerto Rico from Faro de Cabo Rojo to Luquillo, but even in the mountains, at Aibonito, and also on St. Thomas. At Guánica, Mr. E. G. Smyth collected large numbers feeding on *Amaranthus* and Pará grass, and at Garrochales on *Lantana involucrata*, but at Pt. Cangrejos it at times almost defoliates Snow-on-the-Mountain (*Phyllanthus nivosus roseopictus*).

In a sandy field being plowed near the bridge between Palo Seco and Pt. Salinas, numerous skulls of third instar grubs on this beetle were found entangled in the outer threads of Scoliid cocoons from which adults of *Elis haemorrhoidalis* F. usually emerged, altho from some cocoons, the hyperparasite, *Anthrax gorgon* F., came out. This was the first discovery anywhere in Puerto Rico of fresh Scoliid cocoons associated with empty white grub skulls that could be identified. Subsequently, however, Mr. Harold E. Box (1925–334), finding females of this wasp very abundant in restricted localities, collected and transported them to other places where unparasitized grubs were numerous in Aguirre's cane fields. The grubs are so small that they must occur in large numbers to cause any serious damage, and are hardly of economic importance, but it was an interesting experiment, and most successful, for parasitism increased rapidly where the females had been released.

Cane growers in the British West Indies are accustomed to differentiate between the two kinds of May beetles as "brown hard-backs" for the *Lachnosterna*, and "black hard-backs" for those generally black instead of brown. The shiniest and most nearly impunctate of the black hard-backs in what Drs. Stahl and Gundlach listed under the genus *Chalepus*, and, after various changes to *Dyscinetus* and *Parachalepus*, is now called **Chalepides barbata** F. Presumably it was named *barbata*, not after Barbados, where it does not occur, but from the beard of long grey hairs at the rear end of the body projecting from under the elytra. Before the introduction of *Bufo marinus* into Puerto Rico, it was very abundant, especially in the more humid regions, and adults attracted to lights at night might often be a terrific nuisance. At a dance in the open-air pavilion of the Bayamón Saddle & Motor Club, they accumulated in such numbers on the dance floor as to stop the dance, for no sooner was the floor swept clean than additional beetles flew in to impede the progress of the dancers. The beetles are essentially harmless, and their grubs feed only on decaying vegetation in the soil, never, even accidentally, eating live roots. The first flights of adults to light in the spring usually came in mid-April, and by early in May they constituted the vast majority of all the insects coming to light. They proved to be as welcome to *Bufo marinus* for food as were the brown hard-backs, and toad excrement pellets have been noted which contained the remains of as many as 17 of these beetles. Naturally, they became scarce when the introduced toad became most abundant, and even with the present decreased numbers of toads, made but a single one-night appearance at Río Piedras in 1947, most of which was absorbed by the toads, reappearing as excrement pellets by the next morning.

On the night of September 23, 1948, when a hurricane was passing over Matanzas, Cuba, Key West, Florida and the Everglades, but when there was no rain at Río Piedras, and when there had been none in several days,